

OS03: Architecture, Urban Planning and Design

URBANIZATION AND PM10 POLLUTION IN ISKANDAR MALAYSIA

Muhammad Azahar Zikri Zahari and M. Rafee Majid

Department of Urban & Regional Planning, Universiti Teknologi Malaysia

Abstract: This paper discusses the relationship between urbanization and air quality, particularly PM10, in Iskandar Malaysia. As a model for future urban development in Malaysia, Iskandar Malaysia has to meet the social and economic needs of its growing population while taking care of all the environmental challenges that come with rapid urbanization. The occurrence of regional haze episodes in the past has shrouded the region with particulate matters including PM10, but the major cause of the haze was extensive agricultural open burning rather than urbanization. Since urbanization can be a significant contributor to local PM10 concentration, separating locally-generated PM10 from that of the regional source would enable us to investigate the trend in PM10 level due to urbanization. Therefore, a study on the Iskandar Malaysia's PM10 readings from 2000 to 2012 was carried out with the aim to identify the relationship between urbanization and PM10 concentration. The background concentration of the readings was extracted by using the base flow separation process commonly used in the hydrograph study. The extracted background PM10 was then correlated with the level of urbanization as represented by the accretion of built up area. The result shows that air quality as represented by PM10 concentration is inevitably linked to urbanization at the local level notwithstanding the more noticeable but intermittent influence of the regional haze episodes. Iskandar Malaysia therefore needs to also be aware of the air pollution at its doorstep while keeping an eye out for haze from neighbouring countries.

Keywords: Iskandar Malaysia, PM10, Haze, urbanization, air pollution.

INTRODUCTION

The atmosphere of urban area has often been criticized as unhealthy for the population. Based on the monitoring data and ambient air-quality studies, several large cities in Malaysia are faced with increasing level of air pollutants that are not always at acceptable levels (DOE, 2002). Due to this, the Department of Environment (DOE) Malaysia adopted the Air Pollutant Index (API) in order to revise their index system in 1996. The basis for the interpretation of the API had been explained in the Malaysian Ambient Air Quality Guidelines (Table 1: The "safe levels" for the listed concentration pollutant). Highlighted in this study, the average threshold limit concentrations for PM10 are 150 $\mu\text{g}/\text{m}^3$ and 50 $\mu\text{g}/\text{m}^3$ for 24-hour and 1-year averaging time respectively.

Table 1 Malaysian ambient air quality guidelines
Pollutant Averaging Malaysia guideline

Pollutant	Averaging Time	Malaysia Guideline	
		Ppm	$\mu\text{g}/\text{m}^3$
Particulate Matter (PM10)	24h		150
	1 year		50
Carbon Monoxide (CO)	1h	30	35
	8h	9	10
Nitrogen Dioxide (NO_2)	1h	0.17	320
	24h	0.04	
Sulphur Dioxide (SO_2)	1h	0.13	350
	24h	0.04	105
Ozone (O_3)	1h	0.1	200
	8h	0.06	120

Source: Department of Environment, Malaysia (2002)

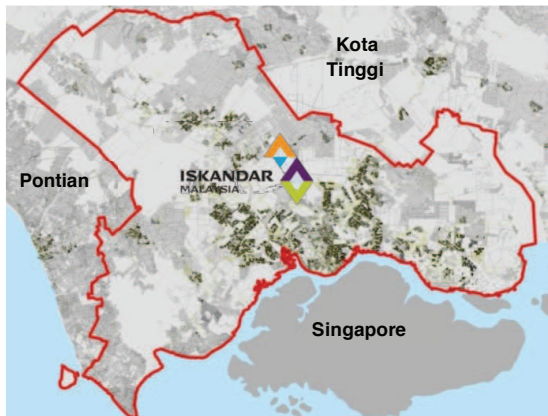


Figure 1 Iskandar Malaysia Development Region

In order to investigate the trend in PM₁₀ level due to increasing urbanization, locally, Iskandar Malaysia had been selected as the study area (Figure 1). As the rate of urbanization in Johor has reached 66.5 percent in 2005, the sixth highest in Malaysia, Iskandar Malaysia's urban areas are expanding due to the Malaysia's development policies (IRDA, 2006). An urban area is defined after the essential characteristic of non-agricultural activities. People who are working in non-agricultural activities concentrate spatially in an urban area (Haapala, 2002). The activities in an urban area are varied, but the most activities are commercial and industrial besides housing. PM₁₀ seriously pollute the urban high traffic area and industrial area (Öztürk, 2011). Unfortunately, the haze periods had shrouded this region, which happen because of the biomass burning by in Indonesia. During the dry season, the levels of PM₁₀ are extremely high throughout the cities (Kim Oanh et al. 2006). Furthermore, the occurrence of biomass burning added with the southwest monsoon wind influence the concentration of PM₁₀ in Malaysia (Abas et al. 2004).



Figure 2 Monitoring stations in Iskandar Malaysia

However, the level of particulate matter is influenced mostly by high traffic and industrial activities during non-haze periods (Afroz et al. 2003). According to Soleiman et al. (2003), near early August 1990, October 1991, and August–October 1994, heavily industrialized urban area in Malaysia such as Klang Valley experienced severe haze episodes. Sansuddin et al. (2010) also stated that two types of haze had hit Klang Valley region, but highlighted in this study is shallow localized haze that arises from trapping the pollutants from anthropogenic emissions. Focusing on Iskandar Malaysia's monitoring stations (Figure 2), haze events were separated by using base flow separation process commonly used in the hydrograph study in representing the background concentration.

METHOD

There are two types of data involved in this study which are the air quality monitoring station and remote sensing data. The PM₁₀ monitoring data were obtained from the Department of Environment, Malaysia whereas the remote sensing data were downloaded from USGS and NASA websites. The data processing was split into two different approaches which involved the urbanization and air quality processes. These two different data relationship was obtained after correlation and regression between both variables (Figure 3).

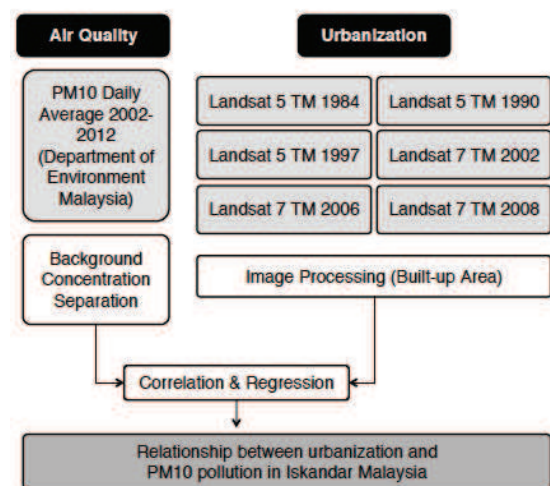


Figure 3 Flow chart of the study tasks

RESULTS AND DISCUSSION

Using remote sensing technology, the urbanization process can be visualized clearly and the map can theoretically indicate the population distribution. Figure 4 shows the process of urbanization in Iskandar Malaysia visually, through the increasing area of built up. Iskandar Malaysia started to urbanize rapidly during the 1990s when the government focused on the industrial sector.

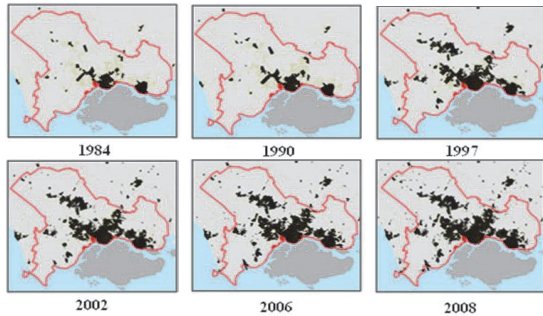


Figure 4 Urbanization of Iskandar Malaysia, 1984-2008

The annual background concentrations of PM10 are plotted against the annual built up area of Iskandar Malaysia in order to study the relationship between both variables. The plotted data have shown that the relationships between the two variables are cubical (Figure 5, Figure 6 and Figure 7). A cubic equation can have more than one solution and that it cannot be solved using linear equation. Transforming the non-linear relationship between the two variables into linear relationship gives a strong correlation $r^2=0.9271$, $r^2=0.8899$ and $r^2=0.8704$ respectively for each station. The positive relationship in that increasing built up area causes an increase of fluctuation in PM10 concentration.

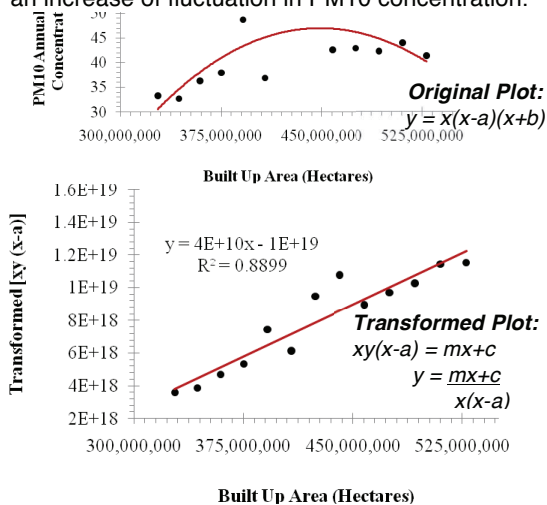


Figure 5 Correlation between built up area and PM10 annual background concentration, SM Pasir Gudang 2

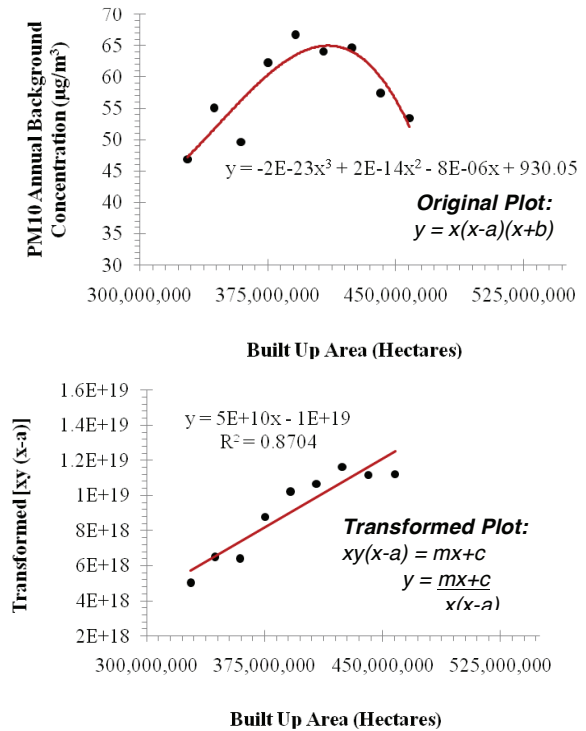
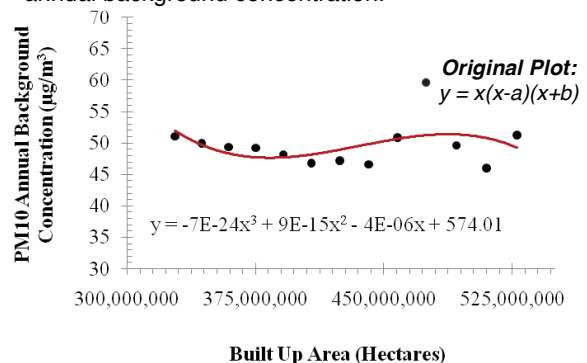


Figure 6 Correlation between built up area and PM10 annual background concentration, SMV Perdagangan

The transformed plot show large positive linear association where the points are close to the linear trend line. Highlighted in the transformed plot above is how a straight line comfortably fits through the data. The scatter about the line is quite small, so there is a strong linear relationship. The slope of the line is positive (small values of built up area correspond to small values of transformed PM10 annual background concentration, large values of built up area correspond to large values of transformed PM10 annual background concentration), so there is a positive correlation between built up area and transformed PM10 annual background concentration.



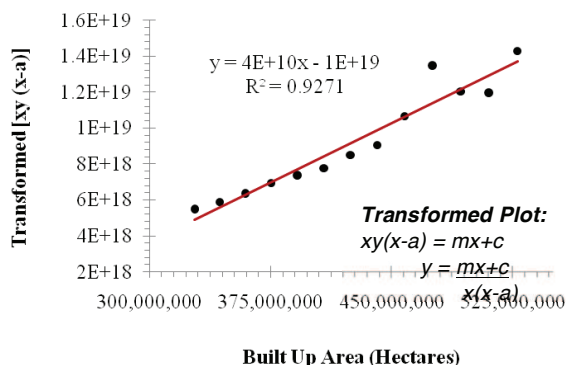


Figure 7 Correlation between built up area and PM10 annual background concentration, SMK Seri Perling

Therefore, this study found that the PM10 concentration is relatively having a cubic relationship with the built up area. The built up area is highly correlated to the transformed PM10 background concentration $[xy(x-a)]$. This may conclude that air quality as represented by PM10 concentration is inevitably linked to urbanization at the local level notwithstanding the more noticeable but intermittent influence of the regional haze episodes. Iskandar Malaysia therefore needs to also be aware of the air pollution at its doorstep while keeping an eye out for haze from neighbouring countries.

CONCLUSION

As a result of urbanization, the PM10 pollution had shrouded Iskandar Malaysia. This fact had been proven by considering the background concentration of PM10 as the shallow localized haze that arises from trapping the pollutants from anthropogenic emissions. The results show that the transformed annual PM10 background concentrations have a positive correlation with the built up area. This fact actually indicates that the annual PM10 background concentrations have a cubic relationship with the built up area (fluctuate) which are on the increase. Therefore, Iskandar Malaysia should keep an eye out on this situation because the PM10 pollution is already increasing at its doorstep besides the threat of haze from neighbouring regions.

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M. Rafee Majid received the B.Sc. (Civil Eng.) from University of Utah, USA; M.Sc. (Environmental Eng.) from University of Oklahoma, USA; and PhD (City and Regional Planning from University of North Carolina, USA. He is the Deputy Dean (Academic) for the Fakulti Alam Bina, UTM.



Muhammad Azahar Zikri Zahari received the Bachelor Degree (Urban and Regional Planning) from Universiti Teknologi Malaysia, Skudai. He is currently a M.Sc. student at Universiti Teknologi Malaysia, Skudai, pursuing his research interest in the environmental planning.